2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

FREQUENCY OF IN-ROW SUBSOILING NECESSARY FOR COASTAL PLAINS SOILS

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Abstract

Less frequent subsoiling could provide adequate loosening of compacted soil profiles for soils which are subject to severe soil compaction. However, most farmers practice annual subsoiling for fear that their soil could prematurely recompact and reduce cotton yields. An experiment was conducted in south-central Alabama using three subsoilers to determine their ability to maintain a loosened soil profile over a one, two, and three-year period. Results in the final year of the experiment didn't find any differences between cotton (Gossypium hirsutum L.) yields resulting from tillage three-, two-, and one-year previous. However, significantly reduced soil compaction was measured in the plots that were annually subsoiled.

Introduction

Soil compaction reduces crop yields throughout the southeastern U.S. and requires many producers to annually subsoil. Subsoiling disrupts compacted soil profiles, allowing roots to proliferate downward to obtain adequate soil moisture (Raper, 2005). Coastal plain soils are typically affected by severe soil compaction and require frequent subsoiling to promote uninhibited root growth.

Traditional methods of subsoiling have combined substantial surface tillage with subsoil disruption. Newer methods of subsoiling, which minimize surface disruption and residue burial, have become much more popular as producers seek to implement conservation tillage technologies which maintain high amounts of crop residue on the soil surface.

However, subsoiling is expensive and time-consuming. Many producers who annually subsoil have asked if the use of conservation tillage practices, which consist of fewer trips across the field, would enable them to move to biennial (every two years) or triennial (every three years) subsoiling. Therefore, an experiment on a Coastal Plains soil was conducted to determine the length of time that soils and crops benefit from the use of several subsoiling implements.

Methods and Materials

The experiment was started in 2001 with spring in-row and non-inversion subsoiling applied at the Alabama Agricultural Experiment Station's E.V. Smith Research Station in Shorter, AL. The Coastal Plains soil type is a Marvyn loamy sand (fine-loamy, kaolinitic, thermic Typic Kanhapludults). Prior to this tillage, the field had been in conventional cotton production for several years.

This study was designed to compare the long-term benefits of four different conservation tillage systems, including a Kelley Manufacturing Company's (Tifton, GA) Rip/Strip in-row subsoiler, a Bigham Brothers' (Lubbock, TX) Paratill® bentleg subsoiler, a Bigham Brothers' Teratill® bentleg subsoiler, and a no-till treatment. Two of the implements were selected (Rip/Strip in-row subsoiler and the Paratill®) because they were commonly being used by producers in this region. The Terratill® was used because it was being marketed as an alternative to the Paratill® with reduced draft and reduced soil disruption.

The experimental design was a randomized complete block with a 3x3 factorial arrangement of treatments augmented with an additional control treatment of no-tillage. The two factors were: 1) tillage implement (in-row subsoiler, Paratill, and Terratill), and 2) tillage application (annual, biennual, and triennual). Each treatment was replicated four times. The experiment was set up in a staggered form with the first set of tillage treatments conducted in the spring of 2001. Annual tillage treatments were conducted with each implement, as well as other tillage treatments that would allow complete results to be obtained for annual tillage, biennual tillage, and triennual tillage in years 2003 and 2004. Only one year of these data were analyzed and presented due to space limitations. All treatments included the use of a rye (*Secale cereale* L.) cover crop.

The plots were four, 30-inch rows wide by 75 ft. long. The center two rows were harvested and weighed to obtain cotton yield. The depth of subsoiling was determined by obtaining several cone-index profiles in plots that were being used to grow conventionally tilled cotton. These measurements showed that the depth of the compacted soil layer began at approximately 12 inches. Therefore, the depth of tillage was set at 13 inches.

Soil strength measurements were obtained with the multiple-probe soil cone penetrometer system (Raper et al., 1999) in the fall of 2004 following cotton harvest. This machine acquired three sets of soil strength measurements in the row from which cone index values were calculated (ASAE Standards, 2004a; ASAE Standards, 2004b). These values of cone index were compared to the 2 MPa cone index level established by Taylor and Gardner (1963) as the highest value at which uninhibited root elongation and growth could take place.

The factorial arrangement of 10 treatments within the randomized complete block was analyzed with an appropriate ANOVA model using SAS. The augmented control treatment effects were also separated using single degree of freedom contrasts. A predetermined significance level of $P \leq 0.10$ was chosen to separate treatment effects.

Results and Discussion

When the experiment culminated in 2004, no significant effect of tillage treatment was found on cotton lint yield ($P \leq 0.73$; Figure 1). However, using single degree of freedom contrasts averaged across years, the Paratilll® was found to improve cotton lint yield (1686 lb/ac) compared to the Terratill® (1576 lb/ac; $P \leq 0.10$). The crop yields were substantially reduced by Hurricane Ivan which affected the area with high wind and heavy rain just days prior to harvest.

Cone index measurements taken in the row show significant reductions in soil strength for the annual subsoiling treatments (Figure 2). However, the soils reconsolidated significantly for both biennial and triennial subsoiling and were similar to the no-till treatment. No difference was found between any of the subsoilers tested; all three implements provided significant reduction in soil strength when used annually.

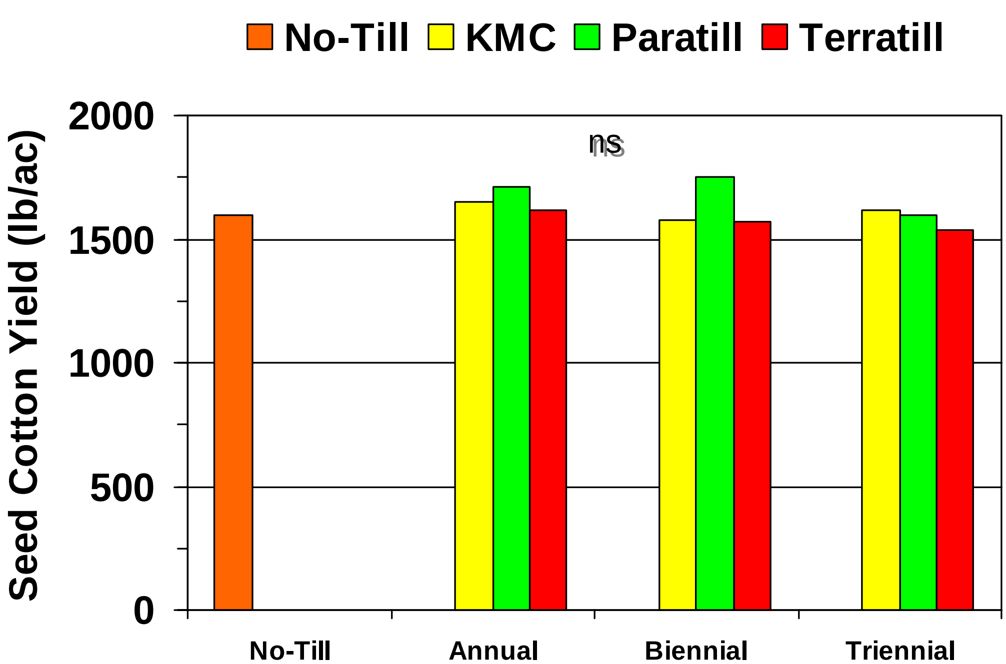

Figure 1. Seed cotton yield in 2004 for tillage treatments.

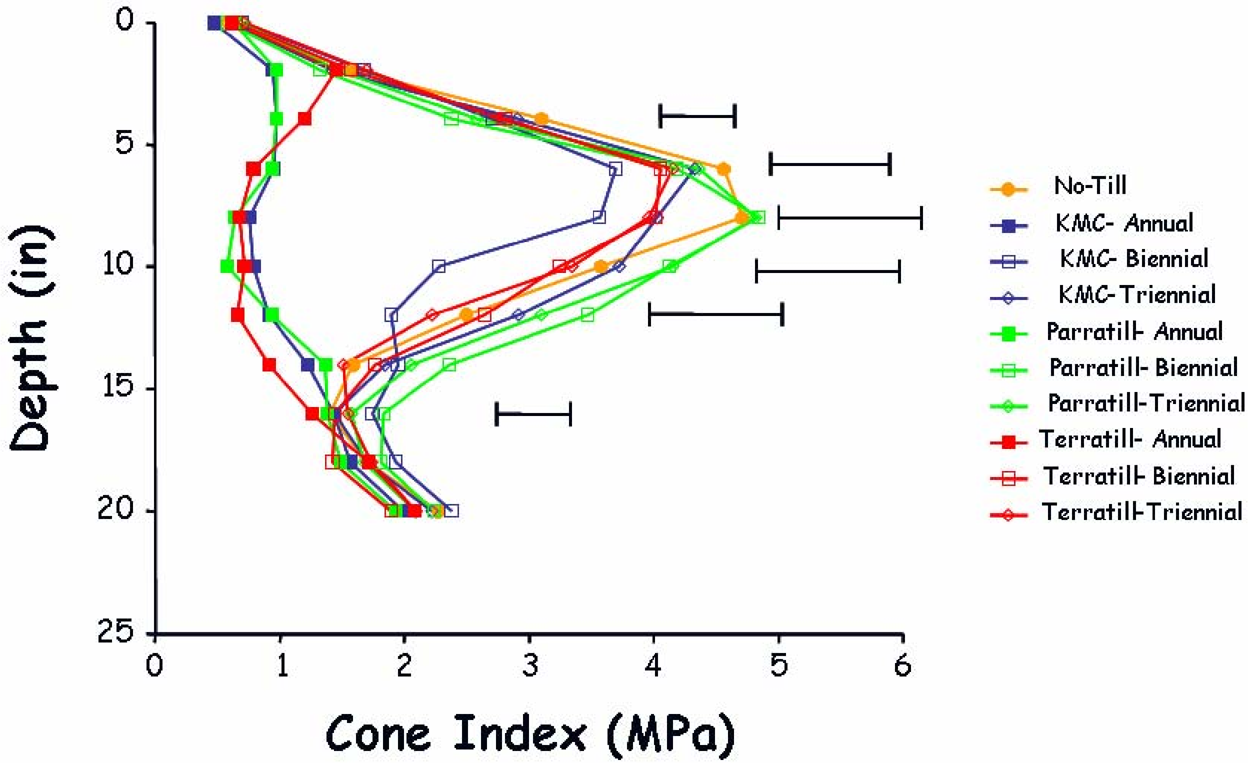

Figure 2. Cone index (in-row position) showing 2 MPa level where root limiting growth conditions occurred. Error bars indicate $LSD_{0.10}$.

Conclusions

1. No differences were found in seed cotton yield between the implements tested or the time since their use. These results were affected by an untimely hurricane which substantially reduced all plot yields.
2. Soil strength was significantly reduced in the row by annual subsoiling. All annual tillage treatments provided ample soil strength reductions for adequate root growth.

Disclaimer

The use of trade names or company names does not imply endorsement by USDA-ARS.

References

ASAE Standards, 50th Edition. 2004b. S313.3: Soil cone penetrometer. St. Joseph, Mich: ASAE.

ASAE Standards, 50th Edition. 2004a. EP542: Procedures for obtaining and reporting data with the soil cone penetrometer. St. Joseph, Mich: ASAE.

Raper, R.L. 2005. Subsoiling. In *Encyclopedia of Soils in the Environment*, 69-75. D. Hillel, D. Rosenzweig, K. Powlson, M. Scow, M. Singer, and D. Sparks, ed. Oxford, U.K.: Elsevier Ltd.

Raper, R.L., B.H. Washington, and J.D. Jarrell. 1999. A tractor-mounted multiple-probe soil cone penetrometer. *Applied Eng. Agric.* 15(4):287-290.

Taylor, H.M., and H.R. Gardner. 1963. Penetration of cotton seedling taproots as influenced by bulk density, moisture content, and strength of soil. *Soil Sci.* 96(3):153-156.